(20)

Tropical Products Institute

G102

Standards, specifications and quality requirements for processed cassava products

Tropical Products Institute

G102

Standards, specifications and quality requirements for processed cassava products

Jean S. Ingram

December 1975

Tropical Products Institute 56/62 Gray's Inn Road London WC1X 8LU
Ministry of Overseas Development

© *Crown copyright* 1975

This report was produced by the Tropical Products Institute, a British Government organisation which helps developing countries to derive greater benefit from their renewable resources. It specialises in post-harvest problems and will be pleased to answer requests for information and advice addressed to the Director.

Material from this report may be reproduced in any non-advertising, non-profit context provided that the source is acknowledged as follows:

Ingram, Jean S. (1975) Standards, specifications and quality requirements for processed cassava products. *Rep. Trop. Prod. Inst.* G102, v + 26 pp.

Permission for commercial reproduction should, however, be sought from the Head, Publications Section, Tropical Products Institute, 56/62 Gray's Inn Road, London WC1X 8LU, England.

Price £0.70, including packing and postage.
No charge is made for this report to official bodies in developing countries.

Tropical Products Institute
ISBN: 0 85954 050 2

Contents

	Page
ACKNOWLEDGEMENTS	v
SUMMARIES	
Summary	1
Résumé	1
Resumen	1
INTRODUCTION	2
OFFICIAL STANDARDS, SPECIFICATIONS AND RECOMMENDED STANDARDS	4
CASSAVA PRODUCTS	
Chips	5
Pellets	7
Tapioca spent pulp	9
Starch	10
Flour	11
Gari	11
'Sago' and grocery tapioca	12
CONCLUSIONS	13
REFERENCES	14
APPENDICES	
1 Brazilian standards for export cassava products	18
2 Thailand standard for tapioca chips	19
3 Indian specification for tapioca as livestock feed	19
4 Indian specification for tapioca spent pulp as livestock feed	19
5 Indian specification for edible tapioca chips	20
6 Tanzania: Requirements for cassava chips	20
7 Brazilian standards for export cassava flour	21
8 Indian specification for edible tapioca flour	22

9	Indian specification for tapioca flour for use in the cotton textile industry	22
10	Paraguay specifications for cassava flour	22
11	Thailand standard for tapioca pellets	22
12	Singapore draft feeding standard for cassava root (starch) products	23
13	Malaysia: Recommended specification for cassava pellets for use in animal feeding	23
14	Indian specification for edible tapioca starch	23
15	Indian specification for tapioca starch for use in the cotton textile industry	23
16	Malaysian specification for edible tapioca starch	24
17	Malaysian specification for industrial tapioca starch	24
18	USA industrial starch standards for cassava starch	24
19	UK Commercial requirements for tapioca starch	24
20	Sri Lanka: Specifications for cassava starch for papermaking	25
21	Indian specification for sago (saboodana)	25
22	Malaysian specifications for pearl tapioca	25
23	USA Federal specifications for pearl and granulated tapioca	25
24	Malagasy specifications for cassava chips, 'bouchons' and 'rounds'	26
25	Malagasy specifications for cassava flour	26
26	Malagasy specifications for crushed cassava and 'briquettes'.	26

ACKNOWLEDGEMENTS

In the preparation of this report, official standards for processed cassava products pertaining to Brazil, India, Malaysia, Paraguay and Thailand have been consulted. The author wishes to acknowledge these sources and other individuals who have readily offered advice in the matter. Special thanks are thus due to the following bodies, arranged in alphabetical order by country:

Secretary General
Conselho Nacional do Comércio Exterior
Rio de Janeiro
BRAZIL

The Director General
Indian Standards Institution
9 Bahadur Shah Zafar Marg
New Delhi 110001
INDIA

(The data given in Appendices 3, 4, 5, 8, 9, 14, 15, 21 has been reproduced with the permission of ISI from Indian Standards No. IS: 1509–1972; IS: 5064–1969; IS: 1317–1969; IS: 1318–1969; IS: 2033–1962; IS: 1319–1969; IS: 1605–1960; IS: 899–1956 respectively, to which inquiries are invited for further details. These standards are available from the ISI at the address shown above)

The Director
Standards Institution of Malaysia
P O Box 544
Kuala Lumpur
MALAYSIA

Dr Ž Muller
FAO, UNDP/SF Project SIN 67/505
P O Box 6, Nee Soon
Singapore 26,
REPUBLIC OF SINGAPORE

The Director
Thai Industrial Standards Institute
Ministry of Industry
Rama VI Street
Bangkok
THAILAND

Instituto Nacional de Tecnología y Normalización
Asunción
PARAGUAY

Summaries

SUMMARY

Standards, specifications and quality requirements for processed cassava products

There is a growing awareness of the need for national and international standardisation of processed cassava products for the international trade. This report summarises information currently available on existing standards, both official and otherwise for cassava products and discusses the related quality parameters. There are variations between standards for the different cassava products and different countries but the quality parameters that are consistently emphasised are moisture, fibre, ash and starch contents plus general cleanliness of the product. Producer countries should therefore aim to achieve and maintain the desired good quality in these products.

RESUME

Normes, spécifications et exigences de qualité pour les produits de transformation du manioc

On prend de plus en plus conscience de la nécessité d'une normalisation sur le plan national et international des produits de transformation du manioc pour le commerce international. Ce rapport récapitule les informations dont on dispose actuellement sur les normes existantes, à la fois officielles et autres, concernant les produits du manioc et on y discute les paramètres de qualité qui y sont liés. Les normes varient suivant les différents produits du manioc et suivant les pays, mais les paramètres de qualité que l'on fait valoir régulièrement sont les teneurs en humidité, en fibres, en cendres et en amidon et, également, la propreté générale du produit. Les pays producteurs doivent par conséquent s'efforcer à atteindre et à maintenir la bonne qualité voulue de ces produits.

RESUMEN

Normas, especificaciónes y exigencias de calidad para productos procesados de mandioca

Existe una conciencia creciente de la necesidad de una normalización, nacional e internacional, de los productos procesados de mandioca para el comercio internacional. Este informe resume la información actualmente disponible sobre las normas existentes, tanto oficiales como no oficiales, para los productos de mandioca, y discute los parámetros de calidad relacionados con las mismas. Existen variaciones entre las normas de los diferentes productos de mandioca y entre las de los diferentes países, pero los parámetros de calidad a los que se concede común importancia son los contenidos de humedad, fibra, ceniza y almidón, además de la limpieza general del producto. Los países productores deben, por tanto, tratar de conseguir y mantener la buena calidad deseada de estos productos.

Introduction

The plant *Manihot esculenta* Crantz is variously known according to the region in which it is grown as cassava, tapioca, manioc, mandioca or yuca. The mature plant has enlarged underground tuberous roots which consist mainly of carbohydrate. These roots provide the staple food for around 200 to 300 million people in many tropical countries, being used either fresh or in various traditionally processed forms. The magnitude of production in the tropics is illustrated by the 1973 production figures published in *FAO Production Yearbook* (1973) quoted in Table 1.

Table 1

World Production of Cassava in 1973

	(thousand tonnes)
Africa	42,384
Latin America	38,152
Far East	24,145
Near East	110
Other Zones	1,627
TOTAL	106,418

Apart from its importance in traditional cassava-based foods, processed cassava has several industrial uses e.g. in food preparations, formulated animal feeding stuffs, breadmaking and bakery products, papermaking, textile sizing, also in adhesives, dextrins and glucose production. To a lesser extent, cassava starch finds minor outlets as a constituent in surgical dressings, mining flocculents, drilling fluids in oil boring and binders for ceramics (Ingram, 1972). It is however mainly in connection with its uses in compound animal feeding stuffs that there has been a greatly increasing interest in cassava during the past decade, although this and other industrial uses of cassava combined still account for only a few per cent of the total global crop. Continental European countries have been using cassava products for at least three decades as an ingredient in animal and poultry feeds (Deja, 1974; Thanh, 1974) but it is only in recent years that cassava has gained a prominent position. The growth of imports into EEC countries, mainly for this purpose is illustrated in Table 2 (after Phillips, 1974).

The growing demand is associated partly with the increased demand for livestock products which in turn has led to increased production of compound animal feeding stuffs in these countries, and partly with rising grain prices and tariff barriers. It is also considered that cassava has great potential in the developing compound feed industries in some of the producer countries (Müller *et al,* 1974; Phillips, 1974; Coursey and Halliday, 1974).

Traditional cassava-based food products of producer countries have not generally been standardised and their quality is very variable, although a few specifications

Table 2

Imports of cassava products into EEC countries between 1962–1972

Year	*Imports (million tonnes)*
1962	0.413
1963	0.484
1964	0.602
1965	0.714
1966	0.884
1967	0.805
1968	0.845
1969	1.204
1970	1.410
1971	1.850
1972	1.900

have been suggested or adopted. In international markets however, legislation for quality control in a wide range of products, including cassava products for export is becoming more widespread. There is a growing awareness of the importance of quality in processed cassava products and of the need for national standardisation of such products.

Bhagwan (1974) has stressed the importance of standardisation and control of quality of animal feeds. As the quality of feeds depends on the quality of the component ingredients, products for incorporation in cassava-based feeds should also conform to standard requirements.

The present report summarises the information currently available on existing standards, both official and otherwise, for processed cassava products, and discusses the related quality parameters. It is hoped that this information will be of use to those authorities who are considering the introduction or modification of standards in this field.

Official standards, specifications and recommended standards

Some official standards for processed cassava products exist: the following have been consulted in the preparation of this report:—

Brazil Conselho Nacional do Comércio Exterior Resolução No 66. Farinha de mandioca e produtos amiláceos (1971)

Indian standard. Specification for tapioca as livestock feed. First Revision. IS: 1509–1972

Indian standard. Specification for tapioca spent pulp as livestock feed. IS: 5064–1969

Indian standard. Specification for edible tapioca chips. First Revision. IS: 1317–1969

Indian standard. Specification for edible tapioca flour. First Revision. IS: 1318–1969

Indian standard. Specification for sago (saboodana). IS: 899–1956

Indian standard. Specification for tapioca flour used in the cotton industry. IS: 2033–1962

Indian standard. Specification for edible tapioca starch. First Revision. IS: 1319–1969

Indian standard. Specification for tapioca starch used in the cotton textile industry. IS: 1605–1960

Malaysian Standard MS 3.15: 1973. Specification for edible tapioca starch

Malaysian Standard MS 3.16: 1973. Specification for industrial tapioca starch

Malaysian Standard MS 3.17: 1973. Specification for pearl tapioca

Norma Paraguaya No. 001, 1966. Harina de Mandioca

Thai Standard for tapioca products TIS 52–2516 (Thai Industrial Standards Institute, Ministry of Industry, 1974)

Thai Standards for tapioca chips. (Ministry of Economic Affairs, 1963)

Thai Standards for tapioca meal (Ministry of Economic Affairs, 1963)

United States Federal Specification N-T-101e June 20 1967. Tapioca

Cassava products

Some standards, official or otherwise, exist for the following cassava products, which are considered in this report.

Chips	– pieces of peeled, sliced, dried tubers, which may be either plain or parboiled
Raspa de mandioca (Brazil)	– cassava chips
Flour	– dry-milled product from chips.
Farinha de raspa (Brazil)	– cassava flour prepared from chips.
Farinha de mandioca (Brazil)	– cassava flour prepared by wet milling (maceration) of peeled roots followed by dry and milling/screening processes.
Pellets	– crushed, ground chips and broken roots which are then compressed into pellets, sometimes with the addition of a binder.
Starch	– wet-milled/screened refined product from root/tubers.
Fecula (Brazil)	– starch
Tapioca (i.e. grocery tapioca)	– flakes, pearls prepared by partial gelatinization of cassava starch.
Tapioca spent pulp	– coarse dry powder, by-product of cassava starch extraction.
'Sago' (India)	– tapioca globules, pearls prepared from pure cassava starch as for grocery tapioca
Gari (West Africa)	– granular food product prepared from fermented, peeled and grated cassava roots.

CHIPS

Standards vary between countries, but in general cover such aspects as moisture content, ash or sand, crude fibre and starch content. The moisture content limit for safe storage of chips is considered to be 12–14% and certainly should not exceed 14%, although some standards give higher tolerance limits. Cassava products can rapidly absorb atmospheric moisture if stored under humid conditions and in the case of chips the moisture content may increase substantially (Ingram and Humphries, 1972). If chips have to undergo prolonged storage in humid conditions, it is advisable to examine them periodically for moisture uptake, mould and insect damage. Ash content, which in practice usually represents mainly extraneous inorganic contaminants such as soil and sand, should not exceed 3%. Crude fibre content is generally around 4% – chips from unpeeled roots or those that are not properly peeled may however show a higher fibre content. Official standards for Brazil, Thailand and India are presented in the

Appendices. The range of specifications for the main constituents of cassava chips is shown in Table 3.

Table 3
Range of specifications for cassava chips, following official standards

	per cent
Moisture	10–14
Starch	70–82
Total Ash	1.8–3.0
Crude Fibre	2.1–5.0

Raw (unprocessed) cassava can be poisonous. Bolhuis (1954) regards a level of below 50 mg HCN/kg freshly peeled root as innocuous; 50–100 as moderately poisonous; and over 100 as dangerously poisonous. The level of toxicity is considerably reduced or may even be largely eliminated in the course of processing e.g. peeling, washing, soaking, heating, cooking, drying etc. so that the eventual product may be of fairly low HCN content. There is however scant information on HCN levels in actual cassava products (Coursey, 1973). Where animal feeds in the EEC are concerned, according to Directive 74/63/EEC of the Council of the European Communities (Anon, 1974 a), the permissible maximum limit for HCN in straight feedingstuffs (i.e. materials for sale directly to the farmer) is normally 50 mg/kg except in cassava products when it is 100 mg/kg of material. India and Malagasy have also laid down specifications for permitted HCN content in cassava products for livestock feed. They are 0.03% (300 mg HCN/kg) and 0.02% (200 mg HCN/kg) respectively.

Bacterial spore counts or observations of moulding or fungal decay are not usually made although microbial contamination is known to occur in processed cassava products (Ingram and Humphries, 1972; Int. Tr. Centre, 1968). Pramanik (1971) states that the bacterial spore count should not exceed 10 million per gram of material, but this has not so far been incorporated in any official standard. Adequate drying of cassava chips is important, in order to render them less susceptible to attack by moulds and bacteria during subsequent storage.

The quality of chips is also judged by general appearance i.e. colour, state of dryness, odour and chip size. Chips should have a good clean, white or near white colour, be free from extraneous matter, moulds, insect infestation and damage and possess no peculiar odours. Several size standards exist. Brazilian standards (1971) specify the maximum length of 5 cm for chips for export without reference to thickness. Indian standards (1969a, 1973) specify the maximum thickness of 2 cm for edible chips and 1.5 cm for chips for livestock feed respectively. Lavigne (1966) also quotes 1.5 cm thickness for Malagasy cassava chips. For the international trade, it is generally considered that chip length should not exceed 4 – 5 cm, the reason being that chips that are longer or too thick can jam the mechanisms of handling equipment and are therefore not suitable for bulk handling or silo storage.

Chips, like all other cassava products destined for overseas markets, should be inspected and approved before they are finally packaged and labelled for export. The method and material of packing used is also important. Brazilian standards (1971) state that sacks must be new and of strong texture, made of cotton or similar material: multi-kraft paper bags may also be used. The sacks in all cases should be packed to 45.36 kg, (equal to 100 lb weight). Gunny bags are used in Thailand: according to Thai specifications (1963, 1974) these must be in a good, sound state suitable for transport, i.e. without breaks, leaks and insect infestation, and be free of any odours that might affect the quality of the contents. The mouths of the bags should be tightly sewn across in both directions with double jute twine, using at least eleven stiches in each direction. Indian regulations (1973) stipulate that clean jute or laminated bags should be used for packing. The bags should be machine-stitched or rolled over and hand stitched. They should bear a description of the contents, manufacturer's name, net weight of produce and batch or code number.

Having taken measures to ensure good quality and proper packing of products, storage depots or warehouses must also provide satisfactory conditions for safe storage of cassava products prior to shipment. Premises should be clean and adequately ventilated. Stored cassava products should also be segregated from infestible products, to reduce the risks of cross-infestation.

PELLETS

Cassava pellets, more commonly called tapioca pellets in the international trade, are used extensively as an ingredient in European animal feedingstuffs. Most of the cassava thus consumed comes from Thailand and the Republic of Indonesia whence it was formerly exported in the form of either chips or flour. In the last decade or so however certain German importers introduced pelletising machinery into Thailand (Int. Tr. Centre, 1968; Mathot, 1974; Manurung, 1974) thereby changing the whole pattern of cassava products for animal feeding purposes and consequently the potential of EEC countries also, as a market for cassava. The production of pellets now account for about 80% of the total cassava products. All pelleting in Thailand is by cold process though the possibilities of using steam are under consideration. One German-owned factory originally conditioned the cassava material with steam but later discontinued the treatment because higher tariffs were levied in the EEC countries on tapioca pellets processed by steam (Tjioe, 1973). Three types of pellets are produced in Thailand (Anon 1971b; Lee 1963; Tjioe, 1973). They are:—

'Brand' pellets

Approximately 25% of pellet production is carried out in factories belonging to German shippers who work in co-operation with Thai exporters. These factories are equipped with imported machinery, much of which is German and the pellets produced are designated 'Brand', and sold as such in the EEC countries under the name of the particular manufacturer. One particular brand consists of pellets 2 cm long by 0.4 cm in diameter; another of pellets 2 cm long by 0.8 cm in diameter.
'Brand' pellets are reputed to be superior to 'Native' grades.

'Trakulkam' pellets

A smaller production of pellets is carried out by a factory called 'Trakulkam' using American pelleting machinery. Their product is labelled 'Trakulkam' pellets, and sold as such, in a similar way to 'Brand' pellets.

'Native' pellets

'Native' pellets are produced by Thai pelletisers using Thai – manufactured machinery. The product is sold in the EEC simply as 'native' pellets without any mention of the producer or exporter. Production of 'native' pellets amounts to almost 75% of the total pellet exports.

The benefits of cassava as pellets in feed rations have been widely recognised by shippers, feed manufacturers and others (Int. Tr. Centre, 1968; Mathot, 1974; Müller *et al* 1974). Pelletisation has simplified transport and handling operations, and reduced storage space required by about 25%; the product is more uniform, and is less fragile than are chips for overseas transportation.

The world's major producer and exporter of pellets is Thailand, followed, on a smaller scale, by Indonesia which is a more recent producer of this commodity. Other countries that are seriously interested in cassava pellet production, initially for domestic consumption are Malaysia (Anon, 1970; Müller *et al,* 1974; Pramanik, 1971) and Sri Lanka (Wijeratne, 1974), while Brazil also has a substantial potential capacity (Phillips, 1974). In this report, quality requirements and official standards for pellets are considered mainly in the context of the Thai industry.

Although quality requirements and official standards for Thailand cassava products have been promulgated for several years, the pellet trade has experienced considerable difficulties. These have been attributed to deterioration in quality of exported cassava products, and to disputes over standardisation and quality control. Quality of pellets in terminal markets is affected by a complex of problems within the producer country, involving growers, processors, and exporters. The subject has been fairly fully documented (Anon, 1974 b; Mathot, 1974; Manurung, 1974; Deja, 1974; Thanh, 1974). Standards for Thailand cassava (tapioca) chips and meal for export were first proclaimed by the Minister of Economic Affairs in 1963 (*Thailand 1969 Buyers' Guide),* and specifications covered starch content, 70–72%; moisture content, 13–14%; sand, 2–3%; and fibre content, 4–5%. Recently however, the Thai government required (Anon, 1974b) that:–

(a) All manufacturers of tapioca chips and pellets be licensed by the Thai Industrial Standards Institute (TISI).

(b) Every bag of tapioca chips or pellets leaving the factory must carry the TISI 'symbol of quality'.

The TISI standards for chips and pellets specify only moisture content, sand and fibre. Although the starch content is determined, a limit is not specified for the purpose of standardisation. The prescribed analyses for chips and pellets respectively are shown in Table 4.

Table 4

Thailand standards for cassava chips and pellets

	Per cent
Starch	No limiting factor
Sand per cent, max.	3.0
Fibre per cent, max.	5.0
Moisture per cent, max.	14.0

Note:– If the ash content obtained during sand determination is more than 4.5% of weight, it must be reported.

Source: Unofficial translation of *Standard for tapioca products TIS 52–2516,* (1974), Thai Ind. Standards Inst., Min.Ind. The original version, written in Thai, is the legally binding standard.

According to the TISI *Standard for tapioca products* (1974), Thai chips and pellets must also be free from foreign matter, foreign odours, abnormal colour, insects, mould and rots. Packaging and labelling regulations are also imposed. The packing material must be strong and clean, and have no tears, leaks or abnormal odours. The packaged or bagged product must bear the following information:–

– Name and form of product
– Manufacturer's name
– Net weight

When a manufacturer has complied with the above standards and rules and received the licence from the Industrial Product Standards Council, only then may he use the Standards Mark on his product. These latest measures imposed by the Thai government appear to be in keeping with current trends in international feed standards as discussed by Bindloss (1974).

The European Communities also have regulations for imported cassava pellets, based on the terms laid down by the Verein der Getreidehändler der Hamburg Börse EV (Int. Tr. Centre, 1968; Mathot, 1974). Specifications are shown in Table 5.

Table 5

Specifications for cassava pellets imported into the EEC

		Per cent
Starch	min.	62 (EEC method)
Raw cellulose	max.	5
Sand	max.	3
Moisture	max.	14.0 (Oct–May) 14.3 (June–Sept)

Source: Mathot, 1974

The EEC regulations also stipulate that a maximum of 3% of the weight may consist of a binding agent, e.g. molasses, and starch-containing components. If the proportion exceeds 3%, Customs departments look on the binding agent as part of a compounded product and accordingly a higher agricultural levy has to be paid (Mathot, 1974).

With regard to toxicity, Directive 74/63/EEC of the Council of European Communities (Anon. 1974a) laid down maximum permitted levels for undesirable substances and products in straight feedingstuffs, i.e. those materials for sale directly to the farmer. The maximum permissible content of HCN in cassava products was fixed at 100 mg/kg of material.

TAPIOCA SPENT PULP

Tapioca spent pulp is the by-product or residue from cassava starch extraction. In the trade it is also known by its Malaysian name 'hampas' (Greenstreet and Lambourne, 1933; Mahendranathan, 1971). In India and Malaysia 'spent pulp' is usually fed locally to livestock. It contains soluble carbohydrates and small amounts of protein and mineral nutrients derived mainly from the skin of the tubers. The composition of dried tapioca spent pulp from different factories in Malaysia (Greenstreet and Lambourne, 1933) is shown in Table 6.

Table 6

Composition of dried tapioca spent pulp

	(1) Per cent	(2) Per cent	(3) Per cent
Starch	88.2	90.1	88.3
Crude protein	2.5	1.2	1.9
Crude fibre	7.5	6.8	8.3
Ash	1.5	1.9	1.5

Source: Greenstreet and Lambourne, 1933

In view of the growing cassava starch industry in India, and the large amounts of waste thus available, the Indian Standards Institution adopted official standards (1969d) for spent pulp for use as animal feeding stuff. Tapioca spent pulp is defined by Indian standards as the product obtained after starch has been extracted from raw tubers. The material is dried either artificially or in the sun, then pulverised. The final product is a coarse powder having a creamy white to light brown colour. It should be free from adulterants, and extraneous matter and should not possess any musty, stale or other peculiar odours. It should also be free of fungus and insect infestation. The main parameters of standardisation are moisture content, crude protein, crude fibre and ash content. The requirements prescribed for spent pulp are similar to those for chips and flour for livestock feed, except that a higher limit for crude fibre content up to the

maximum of 15 is allowed compared with 2.5 in the case of chips and flour. The Indian official standards for tapioca spent pulp (1969d) are reproduced in Appendix 4; moisture protein, fibre and ash requirements are shown in Table 7 below.

Table 7

Indian specifications for tapioca spent pulp

		Per cent
Moisture	max.	10
Crude protein	min.	2
Crude fibre	max.	15
Total ash	max.	3

Indian regulations for packing and labelling spent pulp for transportation are similar to those for chips and flour for livestock feed. The product should be packed in clean jute or laminated bags, the mouth of which should be machine-stitched or rolled over and hand-stitched. Bags should then be suitably marked or labelled denoting the contents, manufacturer's name, net weight of content, and batch or code number.

STARCH

Cassava starch is obtained from the tubers by small scale wet extraction processes and is also manufactured industrially on the factory scale (Brautlecht, 1953; Shipman, 1967). The starch has wide applications in industry. It is used in the food industry in a variety of preparations such as sauces, gravies, mustard powders, baby foods, tapioca products, glucose production (Castillo, 1974, Wahby and Eriksen, 1969), in confectionery and as a speciality starch in breadmaking and bakery products (Dendy *et al*, 1970; Knight, 1974); in the paper industry as a sizing material and corrugating medium; in the adhesives industry for dextrins and paste manufacture; and in the textile industry for warp sizing, cloth and felt finishing. Specifications naturally vary according to intended use.

India has approved official standard specifications for starch used for human consumption (ISI: 1969c) and the cotton textile industry (ISI: 1960). Brazil also has standards for export starch (Brasil Conselho Nacional 1971) and in 1973, Malaysia announced standards for edible tapioca starch, and for industrial tapioca starch (Standards Institution of Malaysia, 1973a,b). Other standards for cassava starch, as published by the former Tapioca Institute of America, 1943 are frequently quoted in the cassava literature. This Institute no longer exists however; it was formed during World War II and its specifications may now be obsolete.

Particular industries generally have their own specifications for the cassava products they purchase, to meet the requirements for special end-uses. In many instances, the bulk of cassava starch is not used as imported but is processed further i.e. modified to suit the needs of the particular industry. In all cases however, buyers of cassava starch are interested chiefly in its colour, uniformity, moisture content, cleanliness and pH factor. Additional concerns may be ash content, viscosity, and sensitivity to acids. The most desirable qualities therefore are a clean, white product, free from specks, dirt, insect infestation and mould, with a moisture content usually of about 12 per cent.

Data on official standards and other specifications for cassava starch are given in the Appendices. Typical starch specifications are shown in Table 8 below.

Table 8

Specifications for cassava starch

	India		*Brazil*	*Malaysia*		*USA*		*UK*	*Sri Lanka*
	Edible	Textiles		Edible (Grade A)	Industrial	Paper	Food		Paper
Starch % min. (dry basis)	98.0	98	80	–	–	–	–	–	–
Moisture % max.	12.5	15.0	14	12.5	12.5	13.5	14.0	8-12	15.0
Ash % max. (dry basis)	0.5	0.4	1.0	0.4	0.5	0.2	0.3	–	4.0
Fibre % max. (dry basis)	0.3	0.6	–	0.2	0.8	–	–	–	–
pH	4.5-7.0	>4.8	–	3.8	3.8	6.5-7.0	5.0-7.0	–	5-8.5

FLOUR

Cassava flour is usually prepared by pulverising dried chips in a disintergrator or other type of grinding mill. In Brazil, however, flour (farinha) is produced by two methods, either (1) wet milling i.e. maceration of the cassava tubers followed by dry milling and screening processes or (2) million and screening of dried chips (raspa).

Cassava flour should be white to light cream in colour, free from rancidity, foreign matter and insect infestation. It should not possess any fermented, musty or other objectionable odours. As with cassava chips, cassava flour specifications cover moisture content, starch, ash/sand and crude fibre. It is seen from the official standards (Appendices 1,3,7–10) that flour quality requirements also vary according to the anticipated end-use. For use in animal feedingstuffs, special attention should be paid to the levels of crude fibre and ash respectively. A product that is adulterated with sand, lime, chalk etc., or contains an excess of crude fibre, decreases the digestibility of the ration (Müller *et al*, 1974). Moreover if flour is to be processed further e.g. for pellet manufacture, its quality can have a decided influence on the processing. Factors that affect the pelletising process are protein, starch, fibre and fat contents as well as the presence of impurities (Manurung, 1974). The range of specifications for flour taken from official standards in Brazil, Thailand, India and Paraguay is shown in Table 9. (Fuller date are reproduced in the tables following the official standards given in the Appendices).

Table 9

Range of specifications for cassava flour, following official standards

	per cent
Moisture content	10–14
Starch	70–82
Total ash	1.8–3.0
Crude fibre	1–6

The regulations for packing cassava flour generally resemble those for chips in the respective exporting countries.

GARI

Gari is a traditional West African cassava-based food product generally similar to the Brazilian farinha de mandioca, but in which the grated roots are subjected to a fermentation period.

Good quality gari should be dry, creamy-yellow in colour, without any peculiar odours and of a slightly sour and sharp taste. For safe storage, gari should be dried to a moisture content below 12%, preferably 8–10% (Akinrele *et al*, 1962; Banks,

1962). The grains or particles should be uniform in size and the material should not contain stones, dirt, sand, insects or parts of insects. It should be of low fibre content, and swell to about three times its volume when placed in water. Ofusu (n. d.) studied quality requirements of gari in Ghana and suggested that the main characteristics on which to formulate specifications were moisture, extraneous matter, particle size and swelling capacity. Nearly white, creamy and very light yellowish coloured gari are equally acceptable.

Specifications for good quality gari have been suggested in Nigeria (Akinrele *et al*, 1962) in the context of the industrialisation of gari manufacture. The main features considered were moisture content, swelling capacity, acidity, colour, particle size and HCN content. The suggested quality parameters are given in Table 10.

Table 10

Recommended quality specifications for gari

Moisture content max.	8–10	(%)
Swelling test	300–500	(% volume increase)
Total acidity	0.8–1.2	(%)
HCN	20	(p.p.m.)

'SAGO' 'ARTIFICIAL SAGO' AND GROCERY OR PEARL TAPIOCA

True sago is derived from the pith of the stem of sago palm, *Metroxylon* spp. In India however, the sago of commerce is manufactured from cassava, and is designated 'tapioca sago' as distinct from palm sago. Indian sago, also known as Saboodana, is therefore essentially the same product as that known in the grocery trade as tapioca, i.e. small seed or pearl forms. Similarly in Brazil the term 'artificial sago' is the same as pearl tapioca. Although virtually all the tapioca that enters the United Kingdom is imported from Malaysia (Jones, 1974) official standards were introduced there only in 1973. Other official standards for grocery tapiocas are those of Brazil (granulated flakes and pearl i.e. artificial sago) and India (sago). The United States Federal Specification (N-T-101e, 1967) for pearl and granulated tapioca is concerned mainly with appearance, particle size and packaging procedures. The granulation specifications are shown in Appendix 23. The main considerations for standardisation are usually moisture content, ash and general appearance. Official standards for Brazilian, Indian and Malaysian tapioca pearls, flakes and 'sago' are reproduced in the Appendices. The main analytical requirements are shown in Table 11.

Table 11

Specifications for tapioca pearls and flakes, following official standards

	Pearl	Flakes
Moisture content %	12.5–15.0	15
Total ash %	0.2–0.5	0.2–0.5

In general, tapioca seeds and pearls should be well gelatinised, and possess a white to creamy white colour. The product should also be free-flowing and free from dirt, grit, foreign matter or any off-flavours and odours. Special attention should be paid to screening tapioca in order to obtain a clean product free from discoloured grains and extraneous matter. Since tapioca is used directly for human consumption, it is especially important that it should contain no rodent dirt and other contaminants. Care should also be taken to ensure that hessian bags used for packing tapioca are also thoroughly clean and free from unusual odours. Jones (1974) reports that these problems are considerably reduced if not eliminated by the use of woven polypropylene sacks. The latter provide better protection against damage by rodents. There is a disadvantage however, in that polypropylene sacks are rather slippery so that stacks tend to be unstable.

Conclusions

In international markets, legislation for quality control in a wide range of products including cassava products for export is becoming more widespread. As there is a growing awareness of the need for national and international standardisation of such products, it is important that good quality is achieved and maintained in cassava products for the world trade. Importing countries usually have minimum quality requirements for processed cassava products and producing countries should aim to fulfil these requirements if a profitable export trade is to be conducted. Close supervision of each stage of the manufacturing process and the establishment of a competent quality control authority or system would contribute to achieving a product of the desired quality for export.

There are variations between standards for the different cassava products and different countries but the consistently emphasised quality parameters are moisture, fibre, ash and starch contents plus general cleanliness of the product. Typical specifications for the principal commercial products are shown in Table 12.

Table 12

Typical specifications for commercial cassava products following official standards

		Chips	*Flour*	*Pellets*	*Starch*
Moisture %	max.	14	14	14	14
Fibre %	max.	5	5	5	0.8
Ash %	max.	3	3	3	1
Starch %	min.	70	70	62	80

The relationship between buyers and sellers in international transactions concerning feed materials is also important. (Bindloss, 1974; Pattinson, 1973). The former states that 'If the law of a nation, or of a group of nations such as the EEC working under harmonised law binding upon its members, lays down specific and quantified features of feed materials which must be complied with, it follows that buyers in those countries have to insist on the inclusion of these features in their specifications; because compliance is matter of the law, these will be written into commercial contracts.

Since these contracts have to be accepted by sellers, who thus undertake to meet these features in materials supplied, it is clear that methods of verification must first exist which can be applied under the practical operational conditions of trading, both to the selection by sellers of material capable of meeting contracts, and to the checking of contracted material on receipt by the buyer. Unless such methods exist, such laws, however clearly stated, cannot be effective because they cannot be brought to bear at operational levels.'

This report reviews and discusses related quality factors in existing official and proposed standards for cassava products. It is hoped that the information will be useful to those authorities who are considering the introduction of standards in this field.

References

AKINRELE, I. A., COLLINS, C., COOK, A. S., HOLGATE, R. H., JANAID, Y. and BAUMER, G. 1962. Gari pilot plant (1 ton a day). Results of 3 month trial run. *Fedl Inst. Ind. Res., Nigeria Res. Rep.* No. 13, Fedl. Min. Comm. Ind.

ANON. 1962. Market report for cassava with particular reference to the United Kingdom. *Trop. Prod. Inst. Rep.* 6/62, Appendix 2.

ANON. 1970. Market prospects for Malaysian tapioca products in the Netherlands. *J. Min. Comm. Ind., Malaysia,* **3** (4), 3–7.

ANON. 1971 a. Sago. *The Wealth of India. Industrial Products,* Part 7, 272–276. India: Counc. Sci. Ind. Res.

ANON. 1971 b. The precious root, Thailand's tapioca industry. *Investor* (*Thailand*), December, 993–995.

ANON. 1971 c. Starch and sago from manioc. *Ceylon Ind. Dev. Bd. Industry Prospect, Rep.* No. 18, 2.

ANON. 1974 a. Council Directive of 17 December 1973 on the fixing of maximum permitted levels for undesirable substances and products in feeding-stuffs. *Official J. European Communities,* **17**, No. L.38/31–36.

ANON. 1974 b. The chips are down and the stakes are high. *Investor* (Thailand), December, 73–74.

BANKS, L. 1962. Background information on mechanised gari production as an aid to equipment manufacturers in development work. *Fedl Inst. Ind. Res., Nigeria, Tech. Memo* No. 12 (restricted). Fedl Min. Comm. Ind.

BHAGWAN, H. 1974. Standardisation and quality control of animal feeds. In *Proc. Trop. Prod. Inst. Conference on animal feeds of tropical and sub-tropical origin,* London, England 241–251.

BINDLOSS, A. A. 1974. Current trends in international feed standards. In *Proc. Trop. Prod. Inst. Conference on animal feeds of tropical and sub-tropical origin,* London, England 221–225.

BOLHUIS, G. G. 1954. The toxicity of cassava roots. *Neth. J. agric. Sci.,* **2** (3), 176–185.

BRASIL CONSELHO NACIONAL. 1971. *Farinha de mandioca e produtos amiláceos. Resolução No 66 Conselho Nac. Comércio Ext., Brasil.* (Brazilian standards for export cassava).

BRAUTLECHT, C. A. 1953. *Starch. Its sources, production and uses.* New York: Rheinhold Publishing Co. pages 220–224.

CASTILLO, L. S. 1974. The cassava industry in the Philippines. In *Cassava processing and storage. Proc. Inter-disciplinary Workshop, Pattaya, Thailand,* pp 63–71. Ottawa, Canada: Int. Dev. Res. Centre. IDRC–031e.

COURSEY, D. G. 1973. Cassava as food: toxicity and technology. In *Chronic cassava toxicity: Proc. Inter-disciplinary Workshop, London, England,* pp 27–36. Ottawa, Canada: Int. Develop. Res. Centre, IDRC–010e.

COURSEY, D. G. and HALLIDAY, D. 1974. Cassava as animal feed. *Outlook on Agriculture,* **8** (1), 10–14.

DEJA, T. 1974. Problems of the Thai tapioca trade. In *Cassava processing and storage. Proc. Inter-disciplinary Workshop, Pattaya, Thailand,* pp 51–57. Ottawa, Canada: Int. Dev. Res. Centre. IDRC–031e.

DENDY, D. A. V., CLARKE, P. A. and JAMES, A. W. 1970. The use of blends of wheat and non-wheat flours in breadmaking, *Trop. Sci.,* **12** (2), 131–141.

FAO. 1973. World production of cassava in 1973. *Production Yearbook,* **27**, 86. Rome: Food and Agriculture Organisation of the United Nations.

GREENSTREET, V. R. and LAMBOURNE, J. 1933. Tapioca in Malaya. *Dep. Agric. Str. Settle. Fed. Malay States Gen. Ser.* No. 13, 67.

HRISHI, N. 1974. Problems and prospects in cassava production in India, 59–62 in *Cassava processing and storage. Proc. Inter-disciplinary Workshop, Pattaya, Thailand.* Ottawa, Canada: Int. Dev. Res. Centre, IDRC–031e.

INDIAN STANDARDS INSTITUTION. 1956. *Indian Standard. Specification for tapioca 'Sago' (Saboodana).* IS: 899–1956.

INDIAN STANDARDS INSTITUTION. 1960. *Indian Standard. Specification for tapioca starch for use in the cotton textile industry.* IS: 1605–1960.

INDIAN STANDARDS INSTITUTION. 1962. *Indian Standard. Specification for tapioca flour for use in the cotton textile industry.* IS: 2033–1962.

INDIAN STANDARDS INSTITUTION. 1969 a. *Indian Standard. Specification for edible tapioca chips.* (First revision). IS: 1317–1969.

INDIAN STANDARDS INSTITUTION. 1969 b. *Indian Standard. Specification for edible tapioca flour.* (First revision). IS: 1318–1969.

INDIAN STANDARDS INSTITUTION. 1969 c. *Indian Standard. Specification for edible tapioca starch.* (First revision). IS: 1319–1969.

INDIAN STANDARDS INSTITUTION. 1969 d. *Indian Standard. Specification for tapioca spent pulp as livestock feed.* IS: 5064–1969.

INDIAN STANDARDS INSTITUTION. 1973. *Indian Standard. Specification for tapioca as livestock feed.* (First revision). IS: 1509–1972.

INGRAM, J. S. 1972. Cassava processing: commercially available machinery. *Trop. Prod. Inst. Rep.* G75.

INGRAM, J. S. and HUMPHRIES, J. R. O. 1972. Cassava storage – A review. *Trop. Sci.,* **14** (2), 131–148.

INT. TR. CENTRE. 1968. *The markets for manioc as raw material for compound animal feeding stuffs in The Federal Republic of Germany, The Netherlands and Belgium,* Geneva: UNCTAD/GATT. 94 pp.

JONES, A. 1974. *Notes for the market for grocery tapioca in the United Kingdom and Western Europe.* Trop. Prod. Inst. Unpubl. report.

KNIGHT, J. W. 1974. Speciality food starches. In *Cassava processing and storage, Proc. Inter-disciplinary Workshop, Pattaya, Thailand.* pp 77–87. Ottawa, Canada: Int. Dev. Res. Centre. IDRC–031e.

LAVIGNE, R. 1966. Etude sur séchage du manioc. *Bull. Madagascar.* **16** (240), 442–466.

LEE, S. Y. 1963. Thailand's tapioca. *Far East econ. Rev.,* **41** (4), 233–235.

MAHENDRANATHAM, T. 1971. Potential of tapioca *(Manihot utilissima* Pohl) as a livestock feed. A review. *Malay. agric. J.,* **48** (1), 77–89.

MALAYSIAN STANDARDS INSTITUTION. 1973 a. Specification for edible tapioca starch. *Malaysian Standard* MS 3.15: 1973.

MALAYSIAN STANDARDS INSTITUTION. 1973 b. Specification for industrial tapioca starch. *Malaysian Standard* MS 3.16:1973.

MALAYSIAN STANDARDS INSTITUTION. 1973 c. Specification for pearl tapioca. *Malaysian Standard* MS 3.17:1973.

MANURUNG, F. 1974. Technology of cassava chips and pellets processing in Indonesia, Malaysia and Thailand. In *Cassava processing and storage. Proc. Inter-disciplinary Workshop, Pattaya, Thailand*, pp 89–112. Ottawa, Canada: Int. Dev. Res. Centre, IDRC–031e.

MATHOT, P. J. 1974. Production and export control in Thailand and the marketing in Europe of tapioca pellets. In *Cassava processing and storage. Proc. Inter-disciplinary Workshop, Pattaya, Thailand,* pp 27–42. Ottawa, Canada: Int. Dev. Res. Centre, IDRC–031e.

MÜLLER, Z., CHOU, K. C. and NAH, K. C. 1974. Cassava as a total substitute for cereals in livestock and poultry rations. *World Anim. Rev.* (12), 19–24.

OFUSU, A. (no date). *Some characteristics of gari on which product standardisation may be based.* Unpublished report. Pokoase, Ghana: Crops Res. Inst.

PARAGUAYA INST. NAC. TECNOL. NORMAL. 1966. Harina de mandioca. *Norma Paraguaya,* No. 001.

PATTINSON, I. 1973. Existing quality standards of produce in tropical Africa. *Trop. stored Prod. Inf.* **25**, 35–37. (Special issue, Ibadan Grain Storage Seminar).

PHILLIPS, T. P. 1974. *Cassava utilisation and potential markets.* Ottawa, Canada: Int. Dev. Res. Centre. IDRC–020e, 182 pp.

PRAMANIK, A. 1971. Prospects for tapioca cultivation and pelletization in Malaysia. *Planter,* **47** (543), 240–247.

SCHARENGUIVEL, A. G. 1972. An evaluation of the returns to investment of planting 20,000 acres of jungle land with tapioca. *Rev. agric. Econ. Malaysia,* **4** (1), 1–10. Malaysia: Fedl agric. Market Auth. Min. Agric. Fish.

SHIPMAN, L. 1967. Manufacture of tapioca, arrowroot and sago starches. In *Starch: chemistry and technology* **2** *(industrial aspects),* 103–119. (Eds R. L. Whistler and E. F. Paschall). New York and London: Academic Press Inc.

SINGAPORE PIG & POULTRY RES. INST. 1974. Draft Feeding Standard for cassava root (starch) products. Prepared by Pig and Poultry Research Training Institute for the Government of the Republic of Singapore. (Private communication).

THAI IND. STANDARDS INSTITUTE. 1974. *Standard for tapioca products.* TIS 52–2516. Thai Ind. Standards Inst., Min. Ind., Bangkok, Thailand.

THAI MIN. ECON. AFFAIRS. 1963. In *Thailand 1969 Buyers' Guide. A handbook of export laws and lists of exporters.* 53–55.

THANH, N. C. 1974. Technology of cassava chips and pellets processing in Thailand. In *Cassava processing and storage. Proc. Inter-disciplinary Workshop, Pattaya, Thailand.* pp 113–122. Ottawa, Canada: Int. Dev. Res. Centre. IDRC–031e.

TJIOE, D. 1973. Tapioca – the golden root. *Business Rev.,* (Thailand), March, 12–13.

WAHBY, O. and ERIKSEN, C. G. 1969. *The tapioca industry in W. Malaysia. (Economic Survey).* FAO and Min. Agric. Co-ops. Div. Fd. Technol., Malaysia, 140 pp.

WIJERATNE, W. B. 1974. Cultivation, processing and utilization of cassava in Sri Lanka. In *Cassava processing and storage. Proc. Inter-disciplinary Workshop, Pattaya, Thailand.* pp 73–75. Ottawa, Canada: Int. Dev. Res. Centre.

Appendices

Appendix 1

Brazilian standards for export cassava products

	Referring to groups		1 Starch			2 Tapioca				3 Cassava chips		4 Chip flour	
	Referring to classes					Granulated		Pearl or artificial sago					
	Referring to types		1 or A	2 or B	3 or C	1	2	1	2	1	2	1	2
Characteristics and Tolerance	Starch	% minimum	84.0	82.0	80.0					75.0	70.0	71.0	70.0
	Passage through screen	Mesh (mm)	0.105	0.105	0.105							0.160	0.160
		Passage %	99.0	99.0	99.0							99.0	99.0
	Moisture – % maximum		14.0	14.0	14.0	15.0	15.0	15.0	15.0	13.0	14.0	13.0	14.0
	Breaking point °C		58–83	58–83	58–83								
	Colour*		9A1 10A1 11A1	9A1 10A1 11A1 12A1 13A1	9A1 10A1 11A1 12A1 12B1 13A1	white to ashy cream	white to ash colour	white to ashy cream	white to yellow-ish cream and yellow			10A1 10A2 10B1 10B2 11A1 11A2 11A3 11B1 11B2 11B3 11C1 11C2 11C3 13A1 13A2 13B1 13B2	10A1 10A2 10B1 10B2 11A1 11A2 11A3 11B1 11B2 11B3 11C1 11C2 11C3
	Viscosity		good	regular	weak								
	Acid factor content (ml)		4.5	4.5	6.0								
	pH		4.5–6.5	4.5–6.5	4.0–6.5								
	Acidity (ml % in N/1 NaOH solution)												
	Ash % maximum		0.12	0.3	1.0	0.2	0.5	0.2	0.5	2.0	2.5	2.0	2.5
	Pulp ml		0.5	2.5	3.5					2.0	3.0	2.0	2.0
	Odour					specific		specific		specific		40.0	45.0
	Foreign matter or impurities % max.					0.0	0.0	0.0	0.0	1.0	2.0	0.5	1.0
	Length (cm)									5.0	5.0		

***Footnote** Maerz, A. J. and Paul, M. R. (1950). *A dictionary of colour.* New York: McGraw-Hill Book Co.

Source: Brasil Conselho Nacional do Comércio Exterior, Resolução No. 66, 1971 (Translation by Trop. Prod. Inst.)

Appendix 2

Thailand standard for tapioca chips

	Per cent by weight
Moisture, max.	14.0
Fibre, max.	5.0
Sand, max.	3.0
Starch	No limiting factor

Note: In case the ash content obtained during the determination of sand content is more than 4.5% of weight, this ash content shall also be reported.

Source: Unofficial translation of the *Standard for tapioca products.* TIS 52—2516 (1974), Clause 3. Thai Industrial Standards Institute. The original version, written in Thai, is the legally-binding standard.

Appendix 3

Indian specification for tapioca as livestock feed

		Chips	Flour
Moisture, percent by mass,	max.	10	10
Starch, percent by mass,	min.	82	82
Total ash (on dry basis), percent by mass,	max.	2.5	2.5
Acid insoluble ash (on dry basis), percent by mass	max.	1.0	1.0
Crude fibre (on dry basis), percent by mass,	max.	2.5	2.5
Hydrocyanic acid, percent by mass,	max.	0.03	0.03
Alcoholic acidity (as H_2SO_4) in 90 percent alsochol, percent by mass,	max.	—	0.15

Source: *Indian Standard. Specification for tapioca as livestock feed (First revision).* IS: 1509—1972.

Appendix 4

Indian specification for tapioca spent pulp as livestock feed

Moisture, percent by weight	max.	10
Crude protein, (N x 6.25), percent by weight	min.	2.0
Crude fibre, percent by weight,	max.	15
Total ash, percent by weight,	max.	3
Acid insoluble ash, percent by weight,	max.	1.5

Note: Requirements for crude protein, fibre, total ash and acid insoluble ash are on moisture-free basis.

Source: *Indian Standard. Specification for tapioca spent pulp as livestock feed.* IS: 5064—1969.

Appendix 5

Indian spedification for edible tapioca chips

Moisture, percent by weight,	max.	13.0
Total ash (on dry basis), per cent by weight,	max.	1.80
Acid insoluble ash (on dry basis), percent by weight,	max.	0.10
Crude fibre (on dry basis), percent by weight,	max.	2.10
pH of aqueous extract		4.7 to 7.0
Cold-water solubles (on dry basis), percent by weight,	max.	11.0

Source: *Indian Standard. Specification for edible tapioca chips (First revision)* IS: 1317–1969.

Appendix 6

Tanzania: Requirements for cassava chips

		Per cent by weight
Starch	(dry basis)	75
Raw fibre	(dry basis)	2–3
Ash	(dry basis)	1
Moisture		not given

Source: International Trade Centre, 1968

Appendix 7

Brazilian standards for export cassava flour

Groups	I. *Edible* Lightly roasted, free of cyanide radicle for human consumption									II. *Industrial* Not included in Group I and intended for industrial purposes						
Classes	a. yellow: coloration varying from yellow to dark cream b. white: coloration varying from white to light cream c. other colours															
	Percentages															
Types	Tolerance	Amylaceous substance	Moisture	Strands, fibres and bark	Chips	Acidity	Ash	Conglomerates	Powder	Amylaceous substance	Moisture	Strands, fibres and bark	Chips	Acidity	Ash	Powder
	Type	Min.	Maximum							Min.	Maximum					
	1	75.0	13.0	1.0	1.0	2.0 ml % in N/1 NaOH solution	2.0	0.5	2.5	75.0	13.0	2.0	1.0	3.0 ml % in N/1 NaOH solution	2.0	2.5
	2	72.0	14.0	2.0	2.0		2.0	1.0	5.0	72.0	14.0	4.0	2.0		2.0	5.0
	3	70.0	14.0	4.0	4.0		2.0	2.0	10.0	70.0	14.0	4.0	4.0		2.0	10.0

Source: Brasil Conselho Nacional do Comércio Exterior Resolução No. 66 (1971). Translation by Trop. Prod. Inst.

Appendix 8

Indian specification for edible tapioca flour

Moisture, percent by weight,	max.	13.0
Total ash (on dry basis), percent by weight	max.	1.80
Acid insoluble ash (on dry basis), percent by weight,	max.	0.10
Starch (on dry basis), percent by weight	min.	82.0
Crude fibre (on dry basis), percent by weight,	max.	2.10
pH of aqueous extract		4.5 to 7.0
Cold-water solubles (dry basis), percent by weight,	max.	11.0

Source: *Indian Standard: Specification for edible tapioca flour (First revision)* IS: 1318–1969.

Appendix 9

Indian specification for tapioca flour for use in the cotton textile industry

Particle size, residue, percent by weight, on IS Sieve 15,	max.	1.0
Moisture content, percent by weight,	max.	15.0
Starch content, percent by weight,	min.	82.0
Ash content, percent by weight,	max.	2.0
Petroleum ether extract, percent by weight,	max.	0.4
Free acidity expressed as ml of 0.1N NaOH per 100 g,	max.	100
Viscosity of 2 percent paste, in seconds, in Redwood No. 1 Viscometer at 75°C,	min.	40.0
Cold water solubles, percent by weight,	max.	9.5
Crude fibre, percent by weight,	max.	2.5
pH of aqueous extract		4.8 to 7

Source: *Indian Standard. Specification for tapioca flour for use in the cotton textile industry.* IS: 2033–1962.

Appendix 10

Paraguay specifications for cassava flour

		Requirement
Moisture per cent,	max.	12.5
Ash per cent,	max.	1.6
pH,	max.	3.5
Starch per cent,	max.	82
	min.	70
Colour		Up to dark cream is acceptable, corresponding to No. 11 on Kent-Jones colorimeter.

Source: *Norma Paraguaya No. 001, 1966. Harina de Mandioca.*

Appendix 11

Thailand standard for tapioca pellets

		Per cent by weight
Moisture	max.	14.0
Fibre	max.	5.0
Sand	max.	3.0
Starch		No limiting factor

Note: If the ash content obtained during the determination of sand content is more than 4.5% of weight, this ash content shall also be reported.

Source: Unofficial translation of the *Standard for tapioca products.* TIS 52–2516 (1974), *Clause 3.* Thai Industrial Standards Institute. The original version, written in Thai, is the legally binding standard.

Appendix 12

Singapore draft feeding standard for cassava root (starch) products

Constituent	Grade	1	2	3	4
Moisture,	max.	14.0	14.0	14.0	14.0
Nitrogen Free Extract,	min.	80.0	78.0	75.0	72.0
Crude Fibre,	max.	2.8	3.5	5.0	5.0
Ash,	max.	2.2	2.5	5.0	5.0

Source: Dr. Z. Müller (FAO, UNDP/SF Project SIN 67/505), Pig and Poultry Research and Training Institute, Singapore. Private communication (1974).

Appendix 13

Malaysia: Recommended specification for cassava pellets for animal feeding

		Per cent
Moisture	max.	10.0
Starch	min.	70.0
Fibre	max.	3.5
Sand	max.	1.0

Source: Scharanguivel, 1972

Appendix 14

Indian specification for edible tapioca starch

Moisture, percent by weight,	max.	12.5
Total ash (on dry basis), percent by weight,	max.	0.50
Acid-insoluble ash (on dry basis), percent by weight,	max.	0.05
Starch (on dry basis), percent by weight,	max.	98.0
Protein (on dry basis), percent by weight,	max.	0.30
Sulphur dioxide, ppm,	max.	100.0
Crude fibre (on dry basis), percent by weight,	max.	0.20
pH of aqueous extract		4.5 to 7.0
Cold-water solubles (on dry basis), percent by weight,	max.	0.70

Source: *Indian Standard. Specification for edible tapioca starch (First revision)* IS: 1319—1969.

Appendix 15

Indian specification for tapioca starch for use in the cotton textile industry

Particle size		To pass IS Sieve 18
Moisture content, percent by weight,	max.	15.0*
Starch content, percent by weight.	min.	98.0
Ash content, percent by weight,	max.	0.4
Protein content, percent by weight,	max.	0.3
Ether extract, percent by weight,	max.	0.2
Free acidity, expressed as ml of 0.1N NaOH per 100 g,	max.	25.0
pH of aqueous extract		Not less than 4.8
Viscosity of 2 percent paste in seconds in Redwood No. 1 Viscometer at 75°C,	min.	44.0
Cold water solubles, percent by weight,	max.	0.4
Crude fibre, percent by weight,	max.	0.6

*This limit for moisture content has been fixed to bring it in conformity with that prescribed in IS: 1184—1957 Specification for Maize Starch for Cotton Textile Industry and also to bring tapioca starch manufactured on the cottage industry scale within the scope of the Standard.

Source: *Indian Standard. Specification for tapioca starch for use in the cotton textile industry.* IS: 1605—1960.

Appendix 16

Malaysian specification for edible tapioca starch

		Grade A	Grade B
Moisture, percent by mass,	max.	12.5	14.0
Total ash (on moisture-free basis), percent by mass,	max.	0.40	0.50
Crude fibre (on moisture-free basis), percent by mass,	max.	0.20	0.20
pH of aqueous extract,	min.	3.8	3.8
Sulphur dioxide (ppm),	max.	100.0	100.0
Particle size*		99	96

Footnote* measured as the minimum percentage (w/w) of the material to pass through a sieve of mesh no. 120 (aperture 125 μ or 0.0049).

Source: *Malaysian Standard MS 3.15:* 1973

Appendix 17

Malaysian specifications for industrial tapioca starch

Moisture, per cent by mass,	max.	12.5
Total ash (on moisture-free basis), percent by mass,	max.	0.50
Crude fibre (on moisture-free basis), per cent by mass,	max.	0.8
pH of aqueous extract,	min.	3.8
Calcium, parts per million,	max.	100

Source: *Malaysian Standard MS 3.16:* 1973

Appendix 18

Some United States industrial starch standards for cassava starch

		Paper manufacturing	Food manufacturing	
			(1)	(2)
Moisture per cent	max.	13.5 (12.5 avg)	12.5	11–14
Ash per cent	max.	0.2	0.15	0.30
Speck count (no./inch^2)	max.	15	8	5
Viscosity peak (Brabender units)		300–900	600	350–450 (at 92.5°C: 280–400)
Pulp		0.25cc/50g	0.1cc/50g	0.5cc/50g
pH		6.5–7.0 (6.7 if desired)	5.5–7.5	5.0–6.5
Acid factor per cent		–	2.6 max.	1.75–2.5
Cleanliness		FDA approved	FDA approved	FDA approved

Source: Phillips, 1974

Appendix 19

UK commercial requirements for tapioca starch

There are no official standards for tapioca starch in the United Kingdom. In general a superior starch will remain in a more or less solid jelly for a considerable time, whereas a weak or inferior starch will show signs of reverting to a thin liquid state in the course of forty-eight hours.

The following are the chief considerations in assessing the quality of tapioca starch:–

Cleanliness

It should be free from specks, dirt, fibre and other extraneous material.

Colour

The starch should be of a good, white colour.

Moisture Content

For a high grade tapioca starch, this should not exceed 12 per cent.

Degree of Fineness

The residue which remains after passing a good quality starch through a 300-mesh screen should not exceed 1 per cent.

Source: Market for cassava starch with particular reference to the UK. *Trop. Prod. Inst. Rep.* 6/62.

Appendix 20

Sri Lanka: Specifications for cassava starch for papermaking

		Grade A	Grade B
Moisture per cent	max.	15.0	15.0
Ash per cent	max.	4.0	4.0
pH of starch		5–8.3	5–8.5
Residue retained on BSI 200 mesh sieve per cent		–	1.0

Source: Anon., 1971 b.

Appendix 21

Indian specification for sago (saboodana)

		IS specification
Moisture, percent,	max.	12.5
Total ash (dry basis), per cent,	max.	0.3
Acid insoluble ash (dry basis), percent,	max.	0.1
Colour of gelatinized alkaline paste in the porcelain cuvette on the lovibond scale		Not deeper than IR + 3Y
pH of aqueous extract		4.5–7.0
Loss of starch in gruel after cooking, percent,	max.	35
Nitrogen, per cent		Not specified
Colour		. .
Crude fibre, per cent		Not specified

Source: *The Wealth of India. Industrial products.* 1971, Part 7, 276.

Appendix 22

Malaysian specifications for pearl tapioca*

Moisture, per cent by mass,	max.	14.0
Total ash (dry basis) per cent by mass,	max.	0.2
pH of aqueous extract,	min.	3.8
Crube fibre, per cent by mass,	max.	0.2

*Small pearl – Not less than 95% by weight of material should pass through a 2400 μm sieve and be retained in a 850 μm sieve

Large pearl – Not less than 95% by weight, of material should pass through a 4.75 mm sieve and be retained in a 2.8 mm sieve

Source: *Malaysian Standard MS 3.17:* 1973

Appendix 23

USA specifications for pearl and granulated tapioca

Pearl	**Particle Size**
Medium	100% should pass through US Standard ¼″ sieve. Not less than 90% by weight should be retained in US Standard No. 4 sieve. Not more than 1% should be 'brokens'.
Small	100% should pass through US Standard No. 6 sieve. Not more than 1% should be 'brokens'.
Granules	
Coarse	100% should pass through US Standard No. 10 sieve. Not less than 95% by weight should be retained in US Standard No. 20 sieve.
Medium	100% should pass through US Standard No. 10 sieve. Not less than 60% by weight should be retained in US Standard No. 20 sieve.
Small	100% should pass through US Standard No. 20 sieve.

Source: *United States Federal Specification N-T-101e June 20, 1967. Tapioca.*

Appendix 24

Malagasy: Specifications for cassava chips*, bouchons†, rounds*†

		Grade 1 Per cent by wt	Grade 2 Per cent by wt
Sizes exceeding standard,	max.	10.0	15.0
Dust, loose bark,	max.	1.0	4.0
Foreign matter,	max.	—	1.0
Mouldy, damaged,	max.	none	15.0
Insect infested		none	none
HCN (dry basis)	max.	0.02	0.02

*Chips — Semi-decorticated pieces, max. thickness 1.5 cm.

†Bouchons — Semi-decorticated pieces, max. length 8 cm.

*†Rounds—Semi-decorticated slices, max. thickness 2 cm.

Source: Lavigne, 1966.

Appendix 25

Malagasy specifications for cassava flour

		Grade 1	Grade 2	Grade 3
Appearance of flour		Fine white	Fine white	Fine
Foreign matter		None	None	None
Particle Size	Sieve No.	23	24	24
	Mesh size	0.16 mm	0.2 mm	0.2 mm
Mouldy, damaged		None	Traces	Traces
Insect infested		None	None	None

Source: Lavigne, 1966

Appendix 26

Malagasy specifications for crushed cassava* and briquettes†

	Type 1	Type 2
Mould and damage	none	Traces
Insect infested	none	none
Foreign matter	none	none

*Crushed cassave — Semi decorticated, crushed and ground.

†Briquettes — Crushed and mechanically compressed.

Source: Lavigne, 1966.

Printed in England for Her Majesty's Stationery Office by Hobbs the Printers Ltd., Southampton